MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

DEE5016 –ELECTRONICS 1

(Diploma in Electronic Engineering)

14 MARCH 2020
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **5** pages (excluding the cover page and appendix).
2. Answer **ALL** questions. All necessary working steps must be shown.
3. Important formulae are provided in the Appendix section.
4. Write all your answers in the answer booklet provided.

QUESTION 1 [25 Marks]

a) Explain how *p*-type semiconductor is formed. Your explanation must include (but not limited to):

- example of atom doped into the semiconductor.
- illustration of covalent bonds between the semiconductor and the impurity atom.
- explanation of the illustration.
- majority and minority carriers.

[10 marks]

b) Referring to Figure 1, answer the following questions:

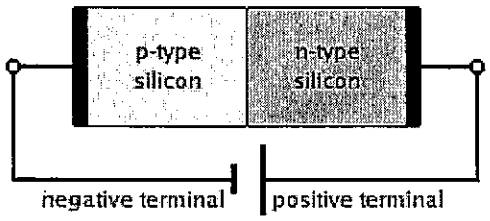

Figure 1

(i) Name the biasing applied.

[1 mark]

(ii) What is the effect of applying the bias voltage to the depletion region? Explain your answer.

[5 marks]

(iii) Such biasing causes a very small current, which is usually neglected. Name the current.

[1 mark]

(iv) Explain how the current named in (iii) could exist.

[4 marks]

(v) The current named in (iii) could increase rapidly if the bias voltage is increased to a value called as _____. Describe '*avalanche*' process that leads to this high current generation. Explain how this current could damage the diode.

[4 marks]

Continued...

QUESTION 2 [25 Marks]

a) Referring to Figure 2, answer the following questions:

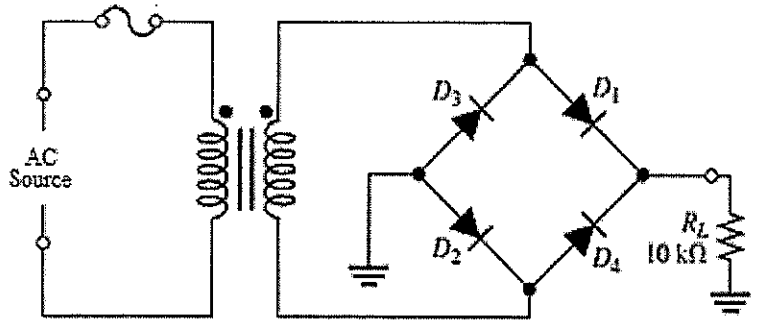

Figure 2

(i) Name the circuit.

[1 mark]

(ii) Explain the operation of the circuit for both positive and negative cycle of the input voltage.

[6 marks]

(iii) Given $V_{p(in)} = 120$ V, $N_{pri} = 2000$, $N_{sec} = 1000$, determine the voltage across R_L and the peak inverse voltage, PIV.

[7 marks]

b) Referring to a limiter circuit shown in Figure 3, answer the following questions:

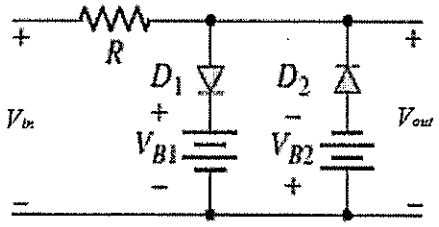

Figure 3

(i) Calculate the V_{out} for both positive and negative cycle of the 10 V ac input, V_{in} given $V_{B1} = 7$ V, and $V_{B2} = 3$ V.

[4 marks]

(ii) Draw the output waveform for at least two cycles of the ac input.

[3 marks]

Continued...

c) Referring to Figure 4, answer the following questions:

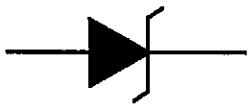

Figure 4

(i) Name the symbol.

[1 mark]

(ii) Draw the *V–I* characteristic of the symbol and shade the operation region. Label the graph accordingly.

[3 marks]

QUESTION 3 [25 Marks]

a) Referring to Figure 5, determine I_B, I_C, I_E, V_{CE}, and V_{CB}, given,

- $V_{BB} = 7$ V
- $V_{CC} = 12$ V
- $R_B = 15$ kΩ
- $R_C = 150$ Ω
- $\beta_{DC} = 80$

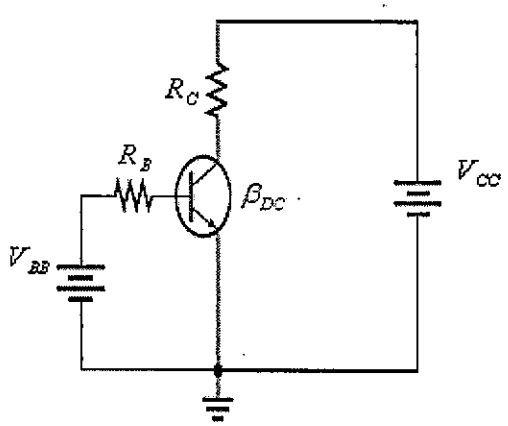

Figure 5

[10 marks]

Continued...

b) State the condition of base current, I_B and collector current, I_C when a transistor is in:

(i) Cutoff region

[2 marks]

(ii) Saturation region

[2 marks]

c) Referring to Figure 6, answer the following questions:

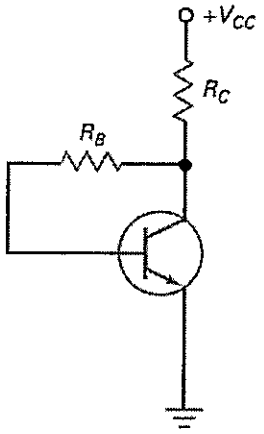

Figure 6

(i) Name the BJT bias method and its advantage.

[3 marks]

(ii) Determine the I_B and Q-point value, based on the given parameters:

- $V_{CC} = 5$ V
- $R_B = 25$ kΩ
- $R_C = 2$ kΩ
- $\beta_{DC} = 100$

[8 marks]

Continued...

QUESTION 4 [25 Marks]

Referring to Figure 7, answer the following questions.

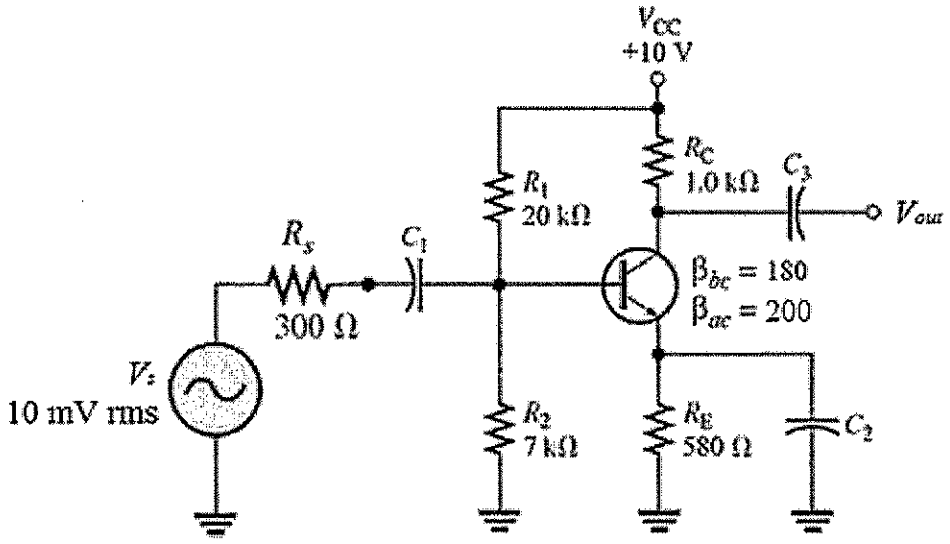

Figure 7

a) Name the amplifier configuration.

[1 mark]

b) Draw the dc equivalent circuit.

[2 marks]

c) Based on your answer in (b), calculate
   (i) DC input resistance at base, $R_{IN(base)}$
   (ii) DC base voltage, V_B
   (iii) DC emitter voltage, V_E
   (iv) DC emitter current, I_E
   (v) DC collector voltage, V_C

[10 marks]

d) Draw the equivalent ac circuit.

[2 marks]

e) From your answer in (d), calculate
   (i) AC total input resistance, $R_{in(tot)}$, given ac $R_{in(base)} = 1.537\ k\Omega$
   (ii) AC base voltage, V_b
   (iii) Voltage gain, A_v given $r_e' = 7.683\ \Omega$
   (iv) Attenuation
   (v) Overall voltage gain, A_v'

[10 marks]

End of Page.

APPENDIX: LIST OF FORMULAE

BJT BIAS	
TERMS	**FORMULAE**
DC load line equation	$I_C = -\frac{1}{R_C}V_{CE} + \frac{V_{CC}}{R_C}$
Voltage divider-bias:	
DC collector and emitter current	$I_C \cong I_E = \frac{V_E}{R_E}$
DC base voltage	$V_B = \frac{R_2 // R_{IN(BASE)}}{R_1 + (R_2 // R_{IN(BASE)})} \times V_{CC}$ $V_B = \frac{R_2}{R_1 + R_2} \times V_{CC}$ if, $R_{IN(BASE)} >> R_2$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C(R_C + R_E)$
DC emitter voltage	$V_E = V_B - V_{BE}$
DC input resistance at the base	$R_{IN(BASE)} = \beta_{DC} R_E$
DC total resistance	$R_T = R_2 // \beta_{DC} R_E$
Base bias:	
DC base current	$I_B = \frac{V_{CC} - V_{BE}}{R_B}$
DC collector current	$I_C = \frac{\beta_{DC}(V_{CC} - V_{BE})}{R_B}$

DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C R_C$
Collector-feedback bias:	
DC base current	$I_B = \frac{V_C - V_{BE}}{R_B}$
DC collector current	$I_C = \frac{V_{CC} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_C}$
DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C R_C$
Emitter bias:	
DC base current	$I_B \cong \frac{I_E}{\beta_{DC}}$
DC collector current	$I_C \cong \frac{-V_{EE} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_E}$
DC emitter current	$I_E = \frac{-V_{EE} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_E}$
DC base voltage	$V_B = V_E + V_{BE}$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_C - V_E$
DC emitter voltage	$V_E = V_{EE} + I_E R_E$

BJT AMPLIFIERS	
TERMS	**FORMULAE**
***r* Parameters:**	
ac base resistance	$r_b^{'} = h_{ie} - \frac{h_{re}\left(h_{fe}+1\right)}{h_{oe}}$
ac collector resistance	$r_c^{'} = \frac{h_{re}+1}{h_{oe}}$
ac emitter resistance	$r_e^{'} = \frac{h_{re}}{h_{oe}}$
Common-base amplifier:	
DC emitter current	$I_E = \frac{V_E}{R_E}$
DC base voltage	$V_B = \frac{R_2}{R_1+R_2} \times V_{CC}$
DC emitter voltage	$V_E = V_B - V_{BE}$
ac output voltage	$V_{out} = V_c$
ac input voltage	$V_{in} = V_e$
ac resistance at emitter	$R_{in(emitter)} \cong r_e^{'}$
ac output resistance	$R_{out} \cong R_C$
Current gain	$A_i \cong 1$

Voltage gain	$A_v \cong \frac{R_c}{r_e'}$
Power gain	$A_p = A_v$
Common-collector amplifier:	
ac input current	$I_{in} = \frac{V_{in}}{R_{in(tot)}}$
ac emitter current	$I_e = \frac{V_e}{R_e}$
ac emitter voltage	$V_e = A_v V_b$
ac input resistance at base	$R_{in(base)} \cong \beta_{ac} R_e$
ac total input resistance	$R_{in(tot)} = R_1 // R_2 // R_{in(base)}$
ac output resistance	$R_{out} \cong \left(\frac{R_s}{\beta_{ac}}\right) // R_E$
Current gain	$A_i = \frac{I_e}{I_{in}}$
Voltage gain	$A_v \cong 1$
Power gain	$A_p = A_i$

Common-emitter amplifier:	
DC collector current	$I_C \cong I_E$
DC base voltage	$V_B = \frac{R_2}{R_1 + R_2} \times V_{CC}$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_C - V_E$
DC emitter current	$I_E = \frac{V_E}{R_E}$
DC emitter voltage	$V_E = V_B - V_{BE}$
DC input resistance at base	$R_{IN(BASE)} = \beta_{DC} R_E$
ac base current	$I_b \cong \frac{I_e}{\beta_{ac}}$
ac base voltage	$V_b = \frac{R_{in(tot)}}{R_s + R_{in(tot)}} \times V_s$ $= I_e r_e'$
ac collector voltage	$V_c = A_v' V_x$
ac total current signal	$I_s = \frac{V_s}{R_{in(tot)} + R_s}$

ac input resistance at base	$R_{in(base)} = \beta_{ac} r'_e$
ac total input resistance	$R_{in(tot)} = R_1 // R_2 // R_{in(base)}$
ac output resistance	$R_{out} \cong R_C$
Current gain	$A_i = \frac{I_c}{I_s}$
Voltage gain	$A_v = \frac{R_C}{r'_e}$ if C_2 exists $A_v = \frac{R_C}{r'_e + R_E}$ if C_2 does not exist
Overall voltage gain	$A'_v = Attenuation \times A_v$
Power gain	$A_p = A'_v A_i$